STATION SYSTEMS
KEY EQUIPMENT NO. 110A, STATIONARY
4 WIRE TOLL LINE TERMINATION CIRCUIT
ARRANGED FOR
TELEPHOTOGRAPH OR TELEPHONE SERVICE

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit provides 4-wire toll line terminating equipment, known as the main station, with facilities for either telegraph or telephone service over the toll line. The toll line is switched, at required transmission levels under control of the main station, to telephotograph equipment for sending or receiving pictures or to the telephone equipment for 2-way telephone service.

1.02 Extension stations for telephone service and/or incoming telephotograph service are provided. (Telephone service at the extension station is under control of the main station and may be out over the toll line and with other extension stations while the main station is set for telephone operation in the TALK condition or with the main station and/or other extension stations while the main station is set for telephotograph operation in the REC or SEND conditions.) The receive-only telephotograph or facsimile machine is always bridged across the receive channel and monitors all incoming pictures.

1.03 The control of the switching functions of the termination equipment is provided by keys located in a 625A1 telephone set. The switching relays and other associated apparatus are provided on mounting plates for relay-rack installation.

1.04 In addition to the main station, a maximum of three extension stations may be provided. An extension station may be equipped with a facsimile machine for receiving pictures and/or a telephone set for telephone service. No provision is included for sending pictures from an extension station.

1.05 Loudspeaker sets may be bridged across the receiving pair for continuous monitoring of the toll line.

SECTION II - DETAILED DESCRIPTION

1. 4-WIRE TOLL LINE TERMINATION - FS1

1.01 The 4-wire toll line termination is provided to match a toll line to telephotograph or telephone equipment. Repeating coils A and B are used to obtain the match and to provide simplex circuits for signal or control functions. A 120N repeating coil is specified with nonloaded cable and a 120P repeating coil with loaded cable. This distinction is necessary as the basis for deriving a hybrid arrangement at some future date to accommodate an additional telephotograph receiver because the type of toll line determines the type of coil required in the hybrid arrangement. A 120P repeating coil is in the transmitting path under all conditions as the telephotograph transmitter is at the main station only and therefore, there is no necessity for any hybrid arrangement.

1.02 When line compensation is required because of a variation in the impedance versus frequency characteristic of certain loaded cable pairs, loading coils L and M, building out capacitors CA and CB, and resistors RA and RB are provided. Patching jacks may be included to provide flexibility in connecting between toll lines and station equipment. The jacks are located on the station side of any impedance compensation coils as the coils, when required, are common to a particular toll line. When patching jacks are provided the circuit is completed through normally closed jack contacts.

1.03 The switching of the toll line between the telephotograph and telephone equipment is under control of the A relay. With the A relay normal, the toll line is connected for telephotograph operation. Either 4-wire or 2-wire telephotograph equipment can be accommodated. With the 4-wire equipment, the receiver is always across the receiving pair and the transmitter is across the terminals of the transmitting pair. In the receiving or REC mode, the transmitting line is terminated by resistor C and the transmitter by resistor D through contacts of the S relay and W wiring. In the transmitting or SEND mode, the transmitter is connected to the TRANS pair, the receiver to the REC pair, and the resistors C and D are out of the circuit.

1.04 With the 2-wire machine, the transmitter and the receiver use the same input to connect to the station. In the REC mode, the TRANS pair is terminated by resistor C. In the TRANS mode, the REC pair is terminated by resistor D. Pads A and B are provided to reduce the transmission level for the telephotograph receiver and transmitter when necessary. The 120H repeating coil J is inserted in the receiving path to avoid interference which may be present due to the use of an extension loudspeaker together with an unbalanced machine input.

1.05 When the A relay is operated and the station is in the TALK mode, the toll line is connected to the telephone equipment for 2-way communication over the toll line. The match of the toll line to the station equipment is maintained as the impedance of the telephone equipment is equivalent to the telephotograph equipment. Pads C and D are provided to reduce the transmission level for the telephone when necessary. Transformers C and D provide taps to allow a maximum of three extension telephone sets to bridge the main station telephone set without changing the impedance of the receiver or transmitter as seen by the toll line. The receiver path of the telephone is terminated in 600 ohms or by the 600-ohm telephone receiver under control of the switch hook. The transmitting path is terminated in 600 ohms or in the telephone transmitter under control of the T relay. Resistors A and B establish a bridge between the transmitter and receiver of the station telephone set and any extension that may be across it under control of the A relay. This enables telephone communication between the main station and any or all extension stations while the main station is in the telephotograph mode of operation.

1.06 A loudspeaker may be connected across the receive channel for monitoring during telephotograph and telephone operation. The loudspeaker set is coupled to the receiving pair by the resistance pad formed by resistors F, G, and H. The input to the loudspeaker set is shorted by the T relay to prevent acoustical feedback while the telephone transmitter is energized.

1.07 The leads designated SXT and SXR are available for signaling, dc control, or dc switching. As there is only one set of simplex leads, additional dc facilities are required if more than one of these functions is required.

2. CONTROL KEY EQUIPMENT

2.01 The control key equipment, consisting of three 598-type pushbutton keys and two turnbutton keys, is incorporated in a 625A1 telephone set. Nonlocking and mechanically interlocking keys are arranged as necessary.

2.02 Three mechanically interlocking keys designated SWITCH, SPLIT, and SWITCH AND LOCK are used to control relays which provide the dc switching features. A characteristic of the 598-type key is that an interlocking key releases the other interlocking keys of the group before it locks itself operated. If it is released before locking, all keys are in the released position. In this particular arrangement, the SPLIT condition occurs when the SPLIT key is depressed or all keys of the group are released.

2.03 The EXCL LOCAL key is nonlocking and controls a W-Z circuit which provides a ground signal used to exclude certain local stations on alternate operations of the key.

2.04 Four interlocking keys designated REC, SEND, TALK, and LOOP TEST control the switching functions to provide telephotograph or telephone service. The toll line is arranged to receive pictures when the REC key is depressed or when all keys of this group are released. The REC key does not provide any electrical control but acts only as a mechanical release key. The SEND key controls the S relay and connects the telephotograph transmitter to the toll line. The TALK key controls the A relay which transfers the toll line between telephone and telephotograph service. The LOOP TEST key controls the N relay which connects the receive pair to the transmit pair of the telephotograph lines for testing on a loop basis.

2.05 The nonlocking RING key controls the R relay which provides ringing current for signaling on the line or to extension stations.

2.06 Three nonlocking keys, EXT 1, EXT 2, and EXT 3, control relays which close transmission signaling paths between the main station and either any or all extension stations. The keys control a W-Z circuit which locks operated and releases on alternate operations of the key.

2.07 The keys designated DC REC and DC SEND perform no function but the lamps are used to indicate the state of the circuit.

2.08 The turn key designated BAT controls the BA relay which controls battery for the indicating lamps of the telephone set.

2.09 The turn key designated BUZ switches the buzzer in or out of the signaling circuit.

2.10 The T relay is located in the telephone set. It is controlled by the push-to-talk switch of the handset. The function of the T relay is to supply battery to the transmitter, close the talk path, and to short-circuit the input to the loudspeaker set to prevent acoustical feedback.

2.11 A ringer is provided in the telephone set for incoming signaling over the toll line. A buzzer is provided for signaling the main station from an extension station.

3. TOLL LINE CONNECTED FOR RECEIVING PICTURES - FS1, 2, AND 3

3.01 The receive condition is the standby condition with all relays normal except the BA relay which furnishes battery to the indicating lamps under control the BAT key. The REC key on the telephone set, upon being depressed, mechanically releases any other interlocking SEND, TALK, or LOOP TEST key, which may have been operated, and returns the equipment to the receive condition.

3.02 The REC lamp is lighted through normally closed contacts of the A and S relays.

3.03 If a 4-wire telephotograph machine is in use, the receiver at 4WRT and 4WRR is connected to the line through contacts of the A and N relays. The transmitting channel is terminated in 600 ohms by resistor C and by the A, N, and S relays. The transmitter is terminated in 600 ohms by resistor D and by the S relay with wiring option W.

3.04 If a 2-wire telephotograph machine is in use, the connection from the line to the receiver at TT and TR is by the A, N, and S relays with V wiring option. The transmitting channel is terminated in 600 ohms by resistor C.

4. TOLL LINE CONNECTED FOR SENDING PICTURES - FS1 AND 2

4.01 The SEND key on the telephone set is depressed to place the equipment in the transmitting condition. The S relay is operated and the SEND lamp is lighted by the S relay.

4.02 For the 4-wire telephotograph machine, the transmit path is completed by the S, N, and A relays. The receiver terminates the receive channel. Resistors C and D are removed from across the transmit path by operation of the S relay.

4.03 For the 2-wire transmitting operation, the transmit path is completed by the S, N, and A relays. The receiving channel is terminated in 600 ohms by resistor D and by the A, N, and S relays with wiring option V. Resistor C is removed from across the transmit path by operation of the S relay.

5. TELEPHOTOGRAPH EXTENSION STATIONS - FS1 AND 4

5.01 The facilities have been provided for a maximum of three facsimile machines to receive pictures at extension stations in addition to the receiver at the main station. The receiving pair provides picture information for the extension stations as well as the main station. The constant impedance to the line is maintained by using a hybrid arrangement of two 120P or 120N repeater coils. Line balance and loading are provided by the compromise network and building out capacitor.

5.02 For the first facsimile machine required, a hybrid arrangement is necessary to provide two receiving paths from the one receiving pair. The hybrid coils consist of an arrangement of two 120P repeater coils for loaded cable or two 120N coils for nonloaded cables. For loaded cable, a compromise network is provided for maintaining a balanced line and for nonloaded cable, a 115D network is provided.

5.03 The receiving path for the first facsimile machine is from repeating coil E on RT2 and RR2 with T wiring option to the 1C pad E and to the facsimile machine input. The path to the main station receiver is from coil A as described in 3.03 and 3.04.

5.04 When two facsimile machines are required, the receiving path is from repeating coil B to input of HYB2. One output of a hybrid coil arrangement drives the input of another hybrid coil to provide two outputs. One output of HYB2 feeds the first facsimile machine through 1C pad E. The other output feeds the second facsimile machine.

5.05 The input to the third facsimile machine is derived from a hybrid which is driven by the second output of the line hybrid. In this arrangement, the main station receiver is transferred from the line hybrid to the second HYB2.

6. TOLL LINE CONNECTED FOR TELEPHONE SERVICE - FS1 AND 2

6.01 The main station equipment is switched to the telephone mode by depressing the TALK key. This operates the A relay. The TALK lamp is lighted through the A relay. Operation of the A relay disconnects the telephotograph equipment and connects the telephone set to the toll line. The telephone receiver path is through contacts of the A relay, C pad, and C autotransformer and terminates in a 600-ohm resistor located in the 625A1 telephone set. The talking path is through contacts of the A relay, D pad, and D autotransformer and also terminates in 600 ohms in the main station telephone set.

6.02 The bridging of the receiver to the transmitter of the telephone set is removed by operation of the A relay.

6.03 Bridging for extension station telephones is shown at the autotransformers C and D where cross-connections at the secondary enable the line to see 600 ohms for one to three extension phones. The extension telephones are not in the circuit at this time but are replaced by 600-ohm resistors J and K to terminate the receiver circuit and transmitter circuit, respectively.

7. MAIN STATION TALKING ON TOLL LINE - FS1 AND 3

7.01 When the termination equipment is arranged for telephone service on the toll line, lifting the handset of the 625A1 telephone set operates the switchhook which removes 600 ohms from across the receive path and connects the 600-ohm U2 receiver across the line. The operation of the push-to-talk button on the handset operates the T relay which applies battery to the transmitter of the handset, short-circuits the input to the loudspeaker amplifier, removes the 600-ohm termination across the transmitting pair of the toll line, and completes the transmitting circuit by closing the secondary of the induction coil.

8. EXTENSION STATION CONNECTED TO TOLL LINE - FS1, 8, AND 9

8.01 When the equipment is arranged for telephone service over the toll line, an extension station may be connected to the line by operating the associated nonlocking EXT key at the main station telephone set. When the key is depressed, the B relay operates through a make contact of the EXT key and locks up through its own EMB contact. The winding of the Z relay is shunted and remains unoperated. When the key is released, the Z relay operates through a contact of the B relay and both relays remain locked operated. The EXT lamp is lighted by the B and RE relays. The extension station telephone set is now connected to the toll line through contacts of the B relay.

8.02 To disconnect the extension telephone, the EXT key is depressed again and the winding of the B relay is shorted through a contact of the Z relay and a contact of the EXT key. The B relay returns to normal, the EXT lamp is extinguished, and the operate path of the Z relay, through a contact of the B relay, is opened. The Z relay is now operated through the B relay and an EXT key contact. When the EXT key is released, the Z relay returns to normal since its return path to ground is opened.

8.03 Resistors M and N are required to limit current while the relay windings are being shunted.

9. EXTENSION STATION TALKING ON TOLL LINE - FS1, 8, AND 9

9.01 When the handset of the extension station telephone is removed from the switchhook, the 600-ohm termination is removed from the receiving line and replaced by the U2 receiver of the extension telephone through the transfer contact of the switchhook. Talking battery is applied to the transmitter through a make contact of the switch hook. Operation of the push-to-talk button operates the TE relay. Contacts of the operated TE relay short-circuit the inputs of the loudspeaker set, remove 600 ohms from across the transmission path, and connect the transmitter to the line. Capacitor CE isolates the line from the battery current.

10. EXTENSION STATION TELEPHONE SEIZES TOLL LINE - FS1, 2, AND 8

10.01 An optional arrangement is provided in which an extension station can seize the toll line at any time. The telephone set is connected to the autotransformer directly by specifying APP Fig. 11 with N option. When the handset is lifted and the push-to-talk button is operated, a ground is applied to the A relay winding causing the A relay to operate. The A relay operated disconnects the toll line from the telephotograph equipment and connects it to the telephone circuit. When the push-to-talk button is released, the A relay returns the circuitry to its original state. Fig. 12 is not required in this arrangement.

11. INTERCOMMUNICATION BETWEEN STATIONS - FS1, 8, AND 9

11.01 Operation of an EXT key at the main station causes the associated B relay to operate and lock up. This connects the associated extension station receiver to the C autotransformer and the transmitter to the D autotransformer. The main station receiver and transmitter are connected to the C and D autotransformers. With the toll line arranged for telephotograph service, the A relay is released and a circuit is completed from the C transformer through 300-ohm resistors A and B to the D transformer. This provides facilities for communication between an extension station and the main station under control of a key at the main station.

12. SIGNALING ON TOLL LINE - FS1, 6, AND 8

12.01 The simplex leads (SX1 and SX2) are used for incoming and outgoing signaling over the toll line. Ringing current on the simplex leads operates the ringer at the main station telephone set and also operates the L relay. The FL relay is operated by the L relay and locks up through its own contact and a contact of the switchhook. The TALK lamp will light steady through FL relay and Q wiring option. For flashing lamps on an incoming call, APP Fig. 9 is specified which provides the interrupter. The operated FL relay supplies power to the motor of the interrupter. The path to the TALK lamp is through the interrupter contact and the FL relay. The TALK lamp flashes while FL is locked up. Lifting the handset releases the FL relay. The TALK key is depressed to connect to the line and the TALK lamp is lighted through the A and FL relays.

12.02 The ringer on extension phones can be operated from the toll line when the A and B relays are operated. With N wiring option, the ringers of the extension phones are connected to the toll line.

12.03 For outgoing signaling to the toll line, both the TALK key and the RING key are operated. The ringing current goes out to the line during the operation of the RING key through the R and A relays. On an outgoing ring, the main station ringer operates as on an incoming call.

12.04 The operation of the L relay provides a short on leads CT and CR during the ringing cycle. This short is used to reset a facsimile machine when applied to its input.

13. SIGNALING BETWEEN MAIN AND EXTENSION STATIONS - FS1, 6, 7, 9, AND 10

13.01 For signaling from the main station to an extension station, the associated EXT key is operated and then the RING key is operated. The ringer at the extension station is operated during time RING key is operated.

13.02 To signal from an extension station to the main station, the RING key at the extension station is operated. The RE relay operates and locks operated through its own contact and contacts of the B relay and the switch hook. The operation of the RE relay provides ground to operate the main station buzzer continuously. Ground is supplied to the interrupter motor by the RE relay and the interrupter operates. An interrupted ground is supplied to the associated EXT lamp at the main station, through the interrupter and RE relay, causing it to flash. Depressing the associated extension key at the main station releases the RE relay which, in turn, removes ground from the interrupter motor, and transfers the EXT lamp from the interrupter circuit to ground through the RE and B relays causing the extension lamp to light steady.

13.03 A rering or ring with the B relay operated operates the buzzer during the time the extension RING key is held depressed.

13.04 If the main station does not answer, the RE relay is released by replacing the extension handset on the switch hook which stops the buzzer at the main station.

13.05 The extension ringer is also operated while the extension RING key is depressed.

14. LOOP TEST

14.01 The function of the loop test is to switch the receiving pair of the 4-wire channel to the transmitting pair to provide a means of testing the local channel from the serving office. Leads RT1 and RR1 are joined to TT1 and TR1 by contacts of the N relay. The relay operation is controlled by the LOOP TEST key at the 625A1 telephone set. The LOOP TEST key is mechanically interlocked with the TALK, SEND, and REC keys, and the LOOP TEST lamp is lighted.

15. DC SWITCHING AND CONTROL - FS5

15.01 The simplex leads of the main station equipment may be used for controlling switching arrangements in the serving test center by providing a ground on one or both simplex leads. The three interlocking keys SWITCH, SPLIT, and SWITCH AND LOCK provide control of the circuit which furnishes these ground signals. Operation of the SPLIT key mechanically releases either the SWITCH or SWITCH AND LOCK key and returns the circuit to the split arrangement in which no ground signals are provided.

16. DC LOCKING CONTROL CIRCUIT - FS1 AND 11

16.01 When the dc locking control circuit is required, it is connected to the simplex leads SX1 and SX2. The simplex leads are connected through the winding of the DCR relay. Switching current over the simplex leads operates relay DCR through a contact of DCS relay. Relay DCR operated lights the red DC REC lamp on the main station telephone console indicating that the line has been seized by a distant station and prevents relay DCS from operating to prevent the local station from seizing the toll line. While the DCR relay is normal, the local station may seize the line by operation of the SEND key which causes the S relay to operate and places a ground on the winding of relay DCS. The operation of DCS opens the DCR operate path, places ground on the transmit simplex lead, and lights the green DC SEND lamp.

17. REMOTE CONTROL CIRCUIT - FS12

17.01 The remote control circuit consists of a W-Z circuit which provides a short-circuit on alternate operations of the associated key. The indicating lamp is on while the short-circuit is being provided.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 Maximum external circuit loop resistance - 2000 ohms.

1.02 Minimum insulation resistance - 20,000 ohms.

1.03 Resistance of shorting circuit to reset facsimile machines - maximum 5 ohms.

2. FUNCTIONAL DESIGNATIONS

2.01 Relays

Designation	Meaning
A	Transfer
A1	Transfer, Aux
B	Transfer, Extension
BA	Battery Supply
DCR	DC Receive
DCS	DC Send
FL	Flashing
L	Signal
N	Loop Test
R	Ring
RE	Ring, Extension
S	Send
SW	Switch
SWL	Switch and Lock
TE	Talk, Extension
W1,Z1	W,Z Circuit
Z	Transfer, Extension

2.02 Apparatus

Designation	Meaning
INT	Interrupter

3. FUNCTIONS

3.01 Provides a 625A1 telephone set at the main station to control the switching of the station equipment to either telephotograph or telephone service.

3.02 Arranged to connect a telephotograph machine to the receiving pair of the 4-wire channel for the reception of pictures over the toll line.

3.03 Arranged to connect a telephotograph machine to the transmitting pair of the 4-wire channel for the transmission of pictures over the toll line.

3.04 Arranged to disconnect the telephotograph machine and to connect the 4-wire telephone set to the toll line.

3.05 Provides hybrid coil arrangements to connect up to three additional receiving only machines to receive pictures simultaneously from one toll line.

3.06 Provides loading coils and building out capacitor to compensate for variation in the impedance versus frequency characteristics of certain loaded cable pairs.

3.07 Provides pads for adjusting transmission levels on the 4-wire channel.

3.08 Provides a relay at the main station for connecting the receiving pair to the transmitting pair of the 4-wire local channel to allow the serving office to test the local channel on a looped basis.

3.09 Provides resistance terminations on the channel to compensate for telephotograph machines or telephone sets which have been disconnected from the channels.

3.10 Arranged to bridge three additional extension stations to the channel when arranged for telephone service.

3.11 Provides intercommunicating facilities between the main station and any or all extension stations while channel is arranged for telephotograph service.

3.12 Provides autotransformers to maintain impedance match between the toll line and a varying number of bridged telephone stations on the channel.

3.13 Provides for a loudspeaker at the main station for monitoring the channel at all times except when the push-to-talk switch in the handset is operated.

3.14 Provides for loudspeakers at extension stations for monitoring the channel except when the push-to-talk switch in the associated extension station handset is operated.

3.15 Provides 2-way signaling over the local channels by the use of 20-cycle ringing current on the simplex legs of the transmitting and receiving pairs.

3.16 Provides 2-way signaling between the main and each extension telephone station.

3.17 Provides an audible ring and visual flashing signal at the main station on incoming calls over the toll line.

3.18 Provides a locked-in common buzzer and flashing line-lamp signal on incoming calls to the main station from an extension station.

3.19 Provides a nonlocked-in buzzer and flashing lamp signal on a rering from an extension station to the main station.

3.20 Provides for manually cutting off the buzzer in the main station telephone set.

3.21 Provides for cutting off the lamps in the main station telephone set.

3.22 Provides a relay which will operate upon receiving a 20-cycle ringing current to short-circuit the input of a facsimile machine for resetting purposes.

3.23 Provides a common ringing key at the main station telephone set for use in conjunction with other keys to signal out on the toll line or to an extension station.

3.24 Provides for one or two dc switching controls over the channel or over separate wires to the serving office.

3.25 Provides a locking control relay circuit which enables the line to be seized in either the receiving mode or the transmitting mode and, while in either of these states, maintains the established control until released from the control point.

3.26 Provides a volume meter arrangement including amplifier and bridging arrangement for connection across receiving channel when required.

3.27 Provides for a 2-wire telephone set for communication with the serving office over a separate pair.

3.28 Provides for the use of connecting blocks, keys, or jacks, as required, at the point of demarcation of ownership.

3.29 Provides a patching jack arrangement to be employed between the toll line and the termination equipment for flexibility in arranging station equipment.

4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a keysheet, the connecting information thereon is to be followed.

(a) 4-Wire Private Line Circuit - SD-69449-01 (typical).

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5336-JRP-FNR